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TASK ANALYSIS SCHEMA BASED ON COGNITIVE STYLE AND SUPPLANTATION--ETC(U)

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TASK ANALYSIS SCHEMA BASED ON COGNITIVE
STYLE AND SUPPLANTATIONAL INSTRUCTIONAL
DESIGN WITH APPLICATION
TO AN AIR FORCE TRAINING COURSE

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11 February 1980

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Approved for public release; distribution unlimited.

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This final report was submitted by the University of Oklahoma, College of Education, Norman, Oklahoma 73019, under contract F33615-77-C0047, project 2313, with Technical Training Division, Air Force Human Resources Laboratory (AFSC), Lowry Air Force Base, Colorado 80230. Mr. Steve Offutt (TT) was the Contract Monitor for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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applied to the tasks specified in the objectives of an Air Force training course. The Weapons Mechanic Course was analyzed using the proposed schema to demonstrate that it was particularly workable and was also well founded theoretically. The schema was found to be relevant to many of the course objectives and to generate recommendations for effective instruction.

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PREFACE

This report draws upon over two years of study of cognitive styles and their impact on Air Force Technical Training performance under contract No. F33615-77-C-0074. Dr. Tillman J. Ragan was the principal investigator. Dr. J. Ron Burkett and Dr. Steven Offutt served, during two different time periods, as the Air Force technical monitor.

Readers who are not currently familiar with the primary dimensions of cognitive style referred to in this report -- field independence/dependence, reflectivity/impulsivity, leveling/sharpening, visual/haptic, and flexible/constricted control -- are encouraged to first read other reports from this project, especially Cognitive Styles: A Review of the Literature (Ragan, T. J., Back, K. T., Stansell, V., Ausburn, L. J., Ausburn, F. B., Butler, P. A., and Huckabay, K., 1979).

On the following pages we report a rationale for instructional design based on cognitive style considerations, learning task analysis, some implications, and an example application of the schema to objectives from the course, Weapons Mechanic. The heart of this report is the task analysis schema developed by Ausburn and Ausburn. To our knowledge, this schema is unique in its attempt to extract a prescriptively oriented synthesis from the psychologically based cognitive style literature, in a form of utility to technical training designers. The need for a task analysis schema based on learners' information processing differences (as measured by tests of cognitive style) was encountered early in our study of cognitive styles and Air Force technical training. The problem, once encountered, was easy to state in simple language: objectives of technical training are not described in course documents in such a way that much sense can be made of them if needs for alternative instruction are in question and existing task analysis schemes are employed. Since first having encountered the problem two years ago, we now believe we have the necessary experience with the impact of cognitive style on training performance to posit a first attempt at meeting the need for a cognitive style-based learning task analysis schema.

The current schema does not possess the elegance of being totally inclusive of all learning tasks, yet it

appears useful in its current form for providing practical suggestions for improving training performance. We hope that training designers will use this schema and anticipate that it will see further development through use and systematic development.

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I. INTRODUCTION

A great deal has been learned, through extensive research, about individual differences among learners in their cognitive styles. It is now well accepted that individuals vary both in cognitive skills (a quantitative measure) and in preference for various modes or manners (a qualitative measure) of gaining, storing, processing, and using information. Individual differences in the processes of cognition have been found to include all processes by which knowledge is acquired and utilized, including perception, thought, memory, mental imagery, conceptualization, and problem solving. However, familiarity with individual differences in cognitive style has little meaning in research on teaching and learning unless such knowledge is incorporated into an instructional design process which actively seeks to provide instructional treatments to interact favorably with learners' cognitive styles. Without being related to instructional design, cognitive style research is comparable to "diagnosis without treatment" in medical research; that is, the research has failed to reach a stage which it is useful to practitioners.

An interaction between cognitive style and instructional treatment can be considered only in the context of a specific learning task. It is not reasonable to search for a general relationship between a cognitive style and an instructional methodology; rather, the reasonable approach is to seek a style/treatment interaction in the context of a specific learning task. The reason for this limitation is clear upon analysis of the relationships among learner characteristics, learning tasks, and instructional treatments.

The relationship between learners and a learning task can be conceptualized as a corridor or "link," which is a connecting path between the two. The requirements of the task define, on the one hand, what is necessary in order to perform successfully; on the other hand, the characteristics of the learner (including cognitive style) influence what the learner is capable of

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performing. If task requirements and learner capabilities are compatible, then the link between task and learner is essentially complete; all that is required of instructional treatment is that it maximize the strength of this link. If, however, there is a discrepancy between task requirements and learner capabilities, the role of instructional treatment as a bridging mechanism is more vital. In such cases, the learner/task link is incomplete, and the instructional treatment required is one which helps to fill in the gap between the task requirement and what the learner is capable of performing unaided. The greater the discrepancy between task requirements and learner capability, the greater the need for the bridging function performed by instructional treatments.

The nature of the link between task and learner is clear when one examines the general nature of cognitive functioning. When stimuli are perceived by an individual, they are not acted upon in their "raw" form; they are processed in some way, according to the learner's cognitive style, structure, and capabilities. These "processed" stimuli are then used to develop a solution to a problem or activity with which the individual is confronted. Fletcher (1969) calls these two phases of the cognitive process "transformation" and "generation." Since the manner in which solutions are generated is dependent on the way the stimuli are transformed, it is quite logical that the learner characteristics which dictate available manners of transformation would have an effect on the solution generated. In situations where a specific learning task requires a specific transformation process of which the learner is not capable, the individual is not likely to generate a successful solution for that particular task without assistance.

Since cognitive style directly concerns the capabilities and preferences of learners in perceiving and utilizing -- that is, in "transforming" -- stimuli, cognitive style can be expected to be an important factor in the ability of learners to meet the requirements of some learning tasks. However, while cognitive style is an important variable in the learner/task link, it is certainly not the only one -- or necessarily even the most important one in all cases. Other learner characteristics such as general ability, adaptability, anxiety, motivation, and familiarity with a task can also be obvious that cognitive style is not relevant to the learner/task link in all learning tasks. Cognitive style is important in this link only when the task is

style-eliciting, or style-dependent; that is, when a basic requirement of the task is information-processing (or "transformation") in a specific manner which is impacted by the characteristics of a particular cognitive style. This implies three important points:

1. To determine the relevance of cognitive style as a variable in a learner/task link, a careful and accurate analysis of specific task information-processing requirements and learner processing styles is necessary.

2. When performance on a task is not largely dependent on a specific processing capability, cognitive style should not be expected to have any important influence on learner performance. If a task allows learners to utilize several alternative styles with equal effectiveness, they can be expected to adapt the task to their preferred cognitive style, with the result that variance in performance is less influenced by cognitive style than by learner variables such as general ability, motivation, attitudes, personality traits, subject-specific aptitudes, and familiarity with the task.

3. When performance on a task is largely dependent on a specific processing ability, cognitive style can be expected to have a much greater impact on the learner/task link and, therefore, on learner performance. In such cases, instructional treatment becomes much more important in completing the link and improving the performance of those learners whose cognitive style is incompatible with the task requirement.

II. AN INFORMATION-PROCESSING CLASSIFICATION OF LEARNING TASKS

The first step in the schema proposed here for interrelating learning tasks, learner cognitive style, and instructional treatments is a task analysis intended to determine the relevance of cognitive style to the learner/task link. The essential question to be answered is whether a task at hand has a basic requirement which might be related to learners' cognitive style. Task analysis has been approached in several ways by various researchers. For example, Bloom, Englehart, Furst, and Krathwohl (1956) have analyzed learning tasks according to levels of complexity of cognitive processes required

(knowledge, application, analysis, etc.). Gagne (1970) has analyzed learning tasks according to types or levels of learning required (discrimination, concept learning, rule learning, etc.). Learning tasks have also been analyzed by Gagne (1968, 1970) in terms of building learning hierarchies of sequential skills, and similarly by Landa (1974) in terms of constructing algorithms, or blueprints of sequential processes to be followed in arriving at a solution to a task. However, these approaches to analyzing learning tasks are not relevant in the schema proposed here. What is important about cognitive style as a learner characteristic relevant to instructional design and treatments is that it influences ability to process information or learning stimuli; certain cognitive styles encourage certain types of processing and inhibit other types. What is therefore important in an analysis of a learning task in a schema which seeks to apply cognitive style as an instructional design variable is what specific types of information processing underlie the task and are required for its successful completion. Several researchers have suggested that consideration of internal cognitive processing within learners when they attack a task is of major importance in task analysis. Glaser (1976) discusses analysis of competent performance as a matter not only of analyzing the knowledge and skills required in the repertoire of successful learners, but also of the demands placed on learners' internal cognitive structures and processes by learning tasks. Resnick (1976), DiVesta (1975), Koran (1972), and Cronbach and Snow (1977) have also stressed the importance of cognitive processes in analyzing learning tasks, learner characteristics, and instructional treatments intended to link them.

Emphasis on information-processing in tasks and learners is basic to the schema proposed here. In this schema, learning task analysis should focus not on instructional factors external to the learner, such as skill sequencing and hierarchy, or on general task characteristics such as level of learning or general class of performance required. It should focus, rather, on basic internal information-processing which the task requires of learners. A task might, for example, require the visualization of an abstract or invisible process (e.g., understanding how combustion occurs inside an engine); the separation from a stimulus field of a specific detail for analysis (e.g., reading a map or

complex diagram); or the retention of several items for comparison (e.g., remembering the details of different types of electronic waveforms).

What is important about these types of cognitive processing factors is that they are relevant to the basic stimuli transformation process, which, in turn, is directly related to the ability to generate solutions to tasks. As specific stimulus-transformation factors, cognitive processing task requirements are much more likely to be related to cognitive style, which is a stimulus-transformation or stimulus-processing variable, than are such task factors as level or type of learning. The cognitive processing requirements of a given task are, in fact, the style-eliciting factors of learning tasks. Basic internal stimulus-processing requirements of tasks are the significant characteristics such as general ability, motivation, attitudes, or special subject-related aptitudes or personality traits. These specific processing requirements must therefore serve as the basis for task analysis which is intended to lead to an interaction between task, cognitive style, and instructional treatment. This kind of task analysis results in a sort of categorization structure in which learning tasks are classified according to the basic information-processing or stimulus transformation activities which they require for successful performance.

After a learning task has been analyzed in terms of its information-processing or stimulus-transformation requirements, the second step in the schema proposed here is to determine which -- if any -- cognitive style dimensions are likely to be relevant. It must be kept in mind that not all tasks have requirements which are related to cognitive style. The basic line of analysis is as follows: Task A requires processing function B, and cognitive style C is likely to be influential in the ability to perform this function. This analysis, of course, requires a thorough working knowledge of the theoretical frameworks and operational manifestations of various cognitive style dimensions. Table 1 gives a basic categorization of eight learning tasks classified by information-processing requirements which are theoretically related to cognitive style, and cognitive style dimensions which are theoretically related to each class of task.

TABLE 1

Information-Processing Classification
of Learning Tasks and Theoretically
Related Cognitive Styles

TASK CLASSIFICATION	RELATED COGNITIVE STYLE(S)
1. Tasks requiring discrimination and analysis of visual details	<ul style="list-style-type: none"> a. Field independence/dependence (ability to disembed stimuli from embedding context) b. Visual/haptic (ability to analyze and synthesize visual details) c. Flexible/constricted field control (ability to concentrate on central task and not be confused by distracting or competing stimuli) d. Reflectivity/impulsivity (ability to analyze a stimulus array systematically and accurately)
2. Tasks requiring comparison or matching of visual details in simultaneously-presented stimuli	<ul style="list-style-type: none"> a. Reflectivity/impulsivity (ability to systematically study and analyze stimulus field) b. Field independence/dependence (ability to separate and analyze details in visual field) c. Visual/haptic (ability to analyze and synthesize visual details) d. Flexible/constricted field control (ability to concentrate on analysis task and not be confused by array of competing stimuli)
3. Tasks requiring visualization of processes or objects	<ul style="list-style-type: none"> a. Visual/haptic (ability to mentally form visual images)

TABLE 1
(Continued)

TASK CLASSIFICATION	RELATED COGNITIVE STYLE(S)
4. Tasks requiring mental manipulation of images	a. Visual/haptic (ability to mentally form and manipulate images)
5. Tasks requiring mental integration of separate visual elements	a. Visual/haptic (ability to mentally form whole images from separately-perceived fragments)
6. Tasks requiring use of kinesthetic or tactile stimuli	a. Visual/haptic (preference for kinesthetic stimuli; ability to transform kinesthetic stimuli into visual images; ability to learn directly from tactile or kinesthetic impressions) b. Field independence/dependence (dependence on visual field; ability to make analytic use of kinesthetic stimuli)
7. Tasks requiring short-term or long-term memory or recall of details of images	a. Visual/haptic (ability to mentally retain visual images) b. Leveling/sharpening (ability to accurately store and recall discrete details and images)
8. Tasks requiring selecting response from among multiple alternatives	a. Reflectivity/impulsivity (ability to make systematic analysis and consideration of all alternatives before making choice)

III. SUPPLANTATIONAL INSTRUCTIONAL DESIGN

Analysis of the information-processing requirements of a learning task reveals what is necessary for successful performance of the task; analysis of related cognitive styles of learners reveals for whom the task is likely to cause difficulties if help is not available. This help can be provided through an appropriate instructional treatment which bridges the gap in the learner/task link created by a discrepancy between the demands of the task and the capabilities of the learner. A sound theoretical basis for designing a bridging treatment is provided by a process which Salomon (1970) calls supplantation. Supplantation may be defined as the explicit and overt performance or alteration of a task requirement which learners would otherwise have to perform covertly for themselves. Our definition extends the one given by Salomon, which stresses the performance of a required task function for learners. It provides for alteration of the task function itself as an alternative form of overt assistance in completing the learner/task link. When instruction is designed so that it supplants by either (a) performing for learners a function required by a learning task, or (b) altering the task requirement so that it better fits learners' abilities or preferences, the link between task and learners is completed.

The definition indicates that supplantation can be of two types: conciliatory and compensatory. Conciliatory supplantation is designed to capitalize on the strengths and preferences of learners and to avoid their weaknesses. Conciliatory supplantation corresponds to what Salomon (1972) terms the "preferential" model, and Cronbach and Snow (1977) the "capitalization" model, for matching learner aptitudes and instructional treatments in aptitude treatment interaction (ATI).

The goal of compensatory supplantation is, as its name implies, to compensate for learners' deficiencies by providing for them the process they cannot provide for themselves. The term "compensatory" is the same one used by both Salomon (1972) and Cronbach and Snow (1977) for the analogous learner/treatment matching model in ATI research. In some cases, an instructional designer is able to choose between the two types of supplantation. In many cases, however, a task simply demands a certain function which cannot be avoided by

conciliatory treatment, and a compensatory treatment is therefore mandatory. The latter is likely to be true in most cases involving a mismatch between basic information-processing requirements of a task and the cognitive style characteristics of learners.

It might appear that there is an alternative to supplantation-based instructional design in situations where the learner's manner of transforming or processing learning stimuli prevents generation of successful solutions to a task. This would involve an attempt to alter the cognitive style which is causing the learner difficulty with a given task. However, Ausburn and Ausburn (1978a) have pointed out that cognitive styles have exhibited strong resistance to long-term and generalizable change and that a given cognitive style might be actually beneficial on a task of a different kind. A better approach, then, would seem to be to view the situation not as a learner-based problem but an instruction-based problem and to employ careful and appropriate instructional design to assist learners in dealing with the requirements of specific tasks with which they are having difficulty. Supplantation provides a means of accomplishing this kind of instructional design.

In a recent paper dealing with using supplantation in instructional design Ausburn and Ausburn (1978b) indicate that a given supplantational treatment should not be expected to have the same effect on all learners. Those learners who have greater need for a supplantational treatment benefit from it most. "Need" is defined as the possession of a characteristic which leads to a low level of aptitude for the type of processing required by a learning task. Thus, the need for supplantation is the inverse of aptitude for the required processing mode. This differential effect of supplantation on learners having different levels of ability to process task stimuli produces a statistically identifiable interaction between learner cognitive style and instructional treatments.

In some cases, the differential effect of a supplantational treatment is a matter of degree rather than of type. In such cases, the treatment is beneficial to both learners with high need for supplantation and those with low need. This usually produces three effects when the performances of the two groups of

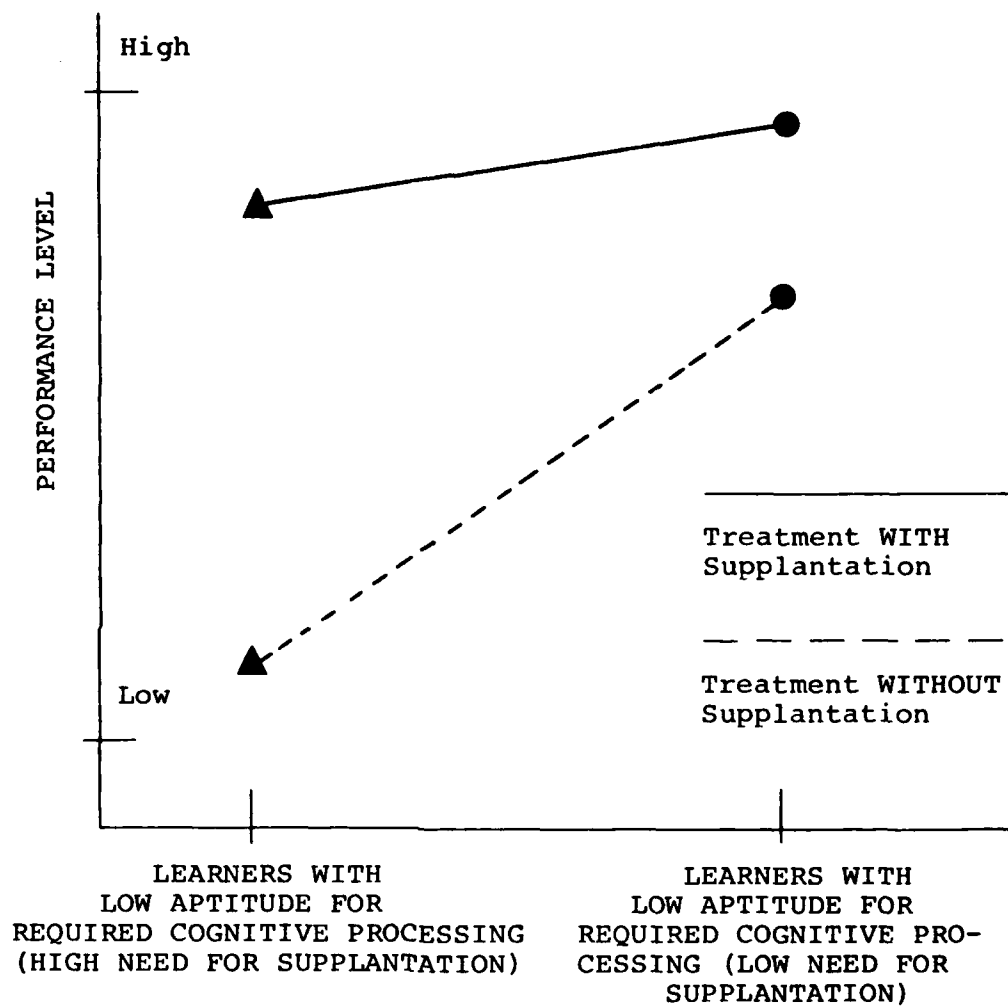


Figure 1

Performance results: single supplantation
treatment appropriate for all learners -
treatment positively related to
learner aptitude

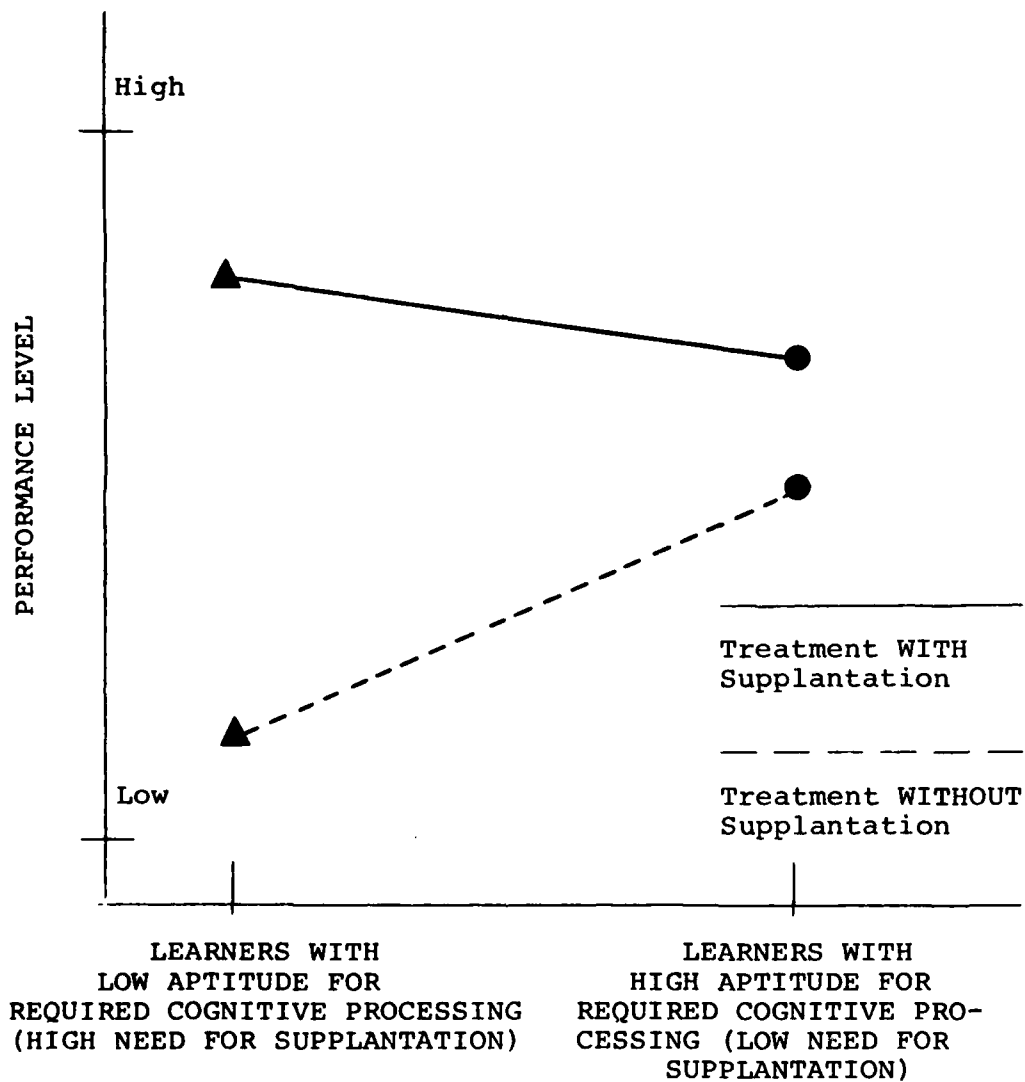


Figure 2

Performance results: single supplantation
treatment appropriate for all learners -
treatment negatively related to
learner aptitude

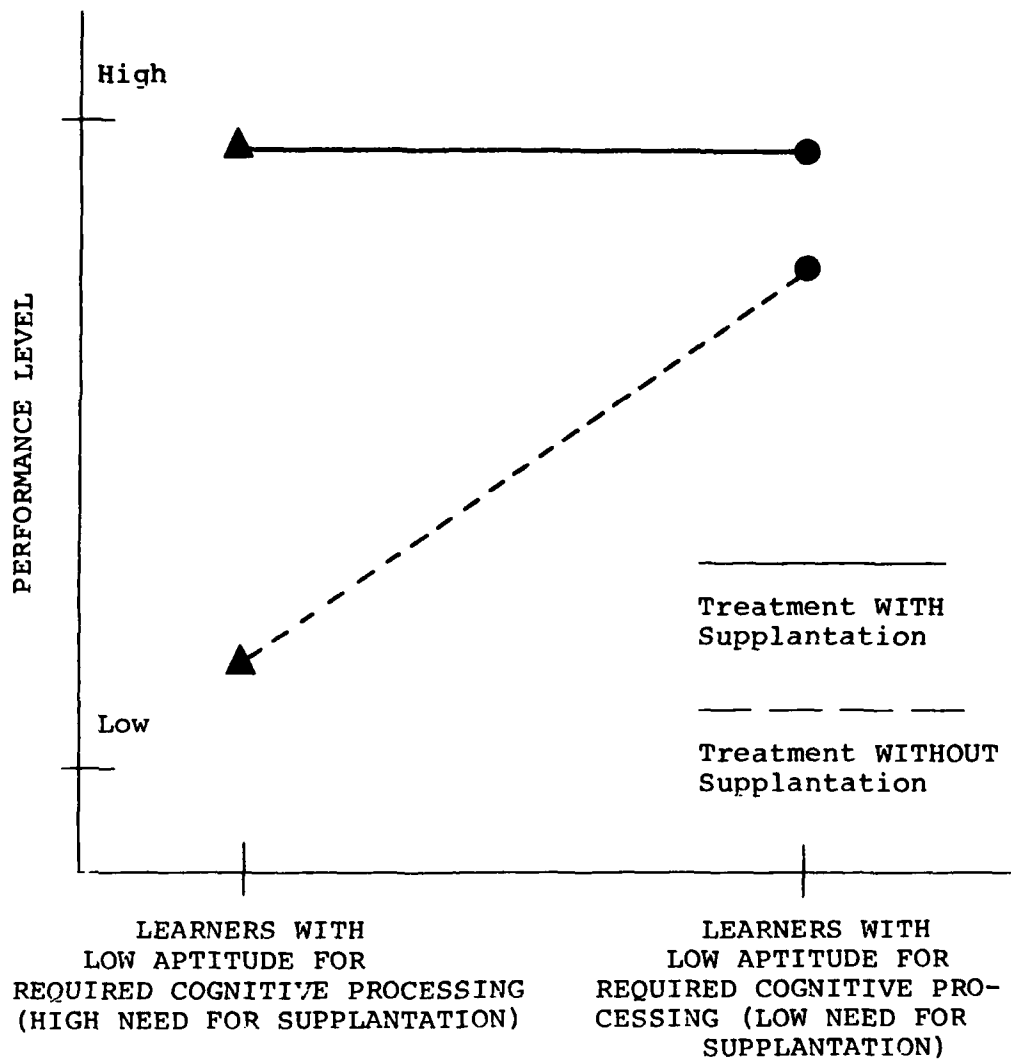


Figure 3

Performance results: single supplantation
treatment appropriate for all learners -
treatment neutrally related to
learner aptitude

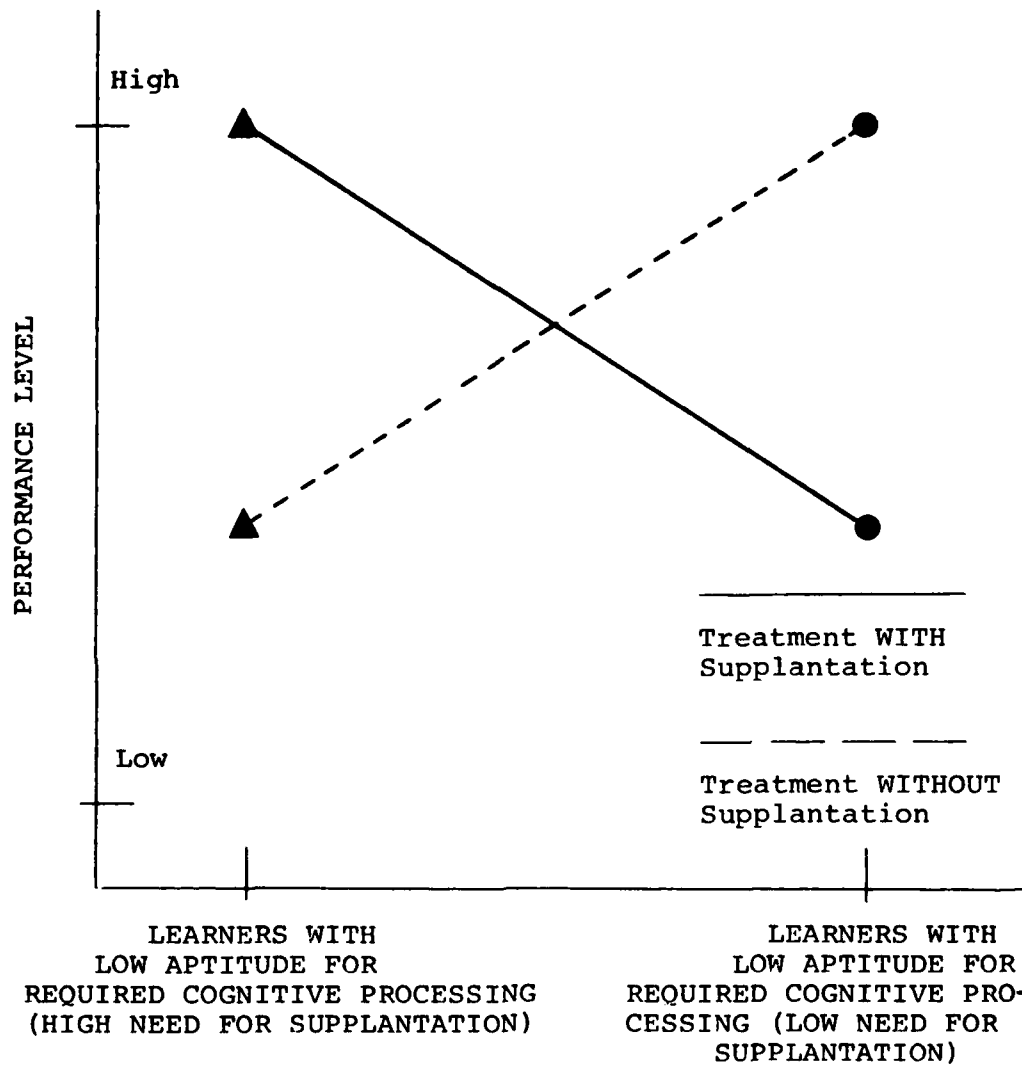


Figure 4

Performance results: dual instructional treatments appropriate - disordinal interaction

learners are compared under conditions of presence and absence of the supplantational treatment:

1. The supplantational treatment is superior to the non-supplantational one for both high-need and low-need learners.

2. The difference in achievement between the high and low-need groups is smaller when the supplantational treatment is applied.

3. The high-need group benefits more from the supplantational treatment than does the low-need group, producing an "ordinal" interaction between cognitive style and instructional treatment.

Ausburn and Ausburn (1978b) discuss three variations of the case in which an ordinal interaction occurs between need for supplantation and instructional treatment and a single supplantational instructional treatment is facilitative for all learners. These are illustrated in Figures 1, 2, and 3. In all three of these variations, the three effects listed above are present. The difference in the three cases is a matter of whether the supplantational treatment is positively, negatively, or neutrally related to learner aptitude.

In some cases, the differential effect of a supplantational treatment on high-need and low-need learners is a matter of type rather than of degree. In these cases, the supplantation which benefits high-need learners and raises their performance level disrupts low-need learners and lowers their performance level. This situation produces the classic "disordinal" interaction of ATI research and shows a need for two different instructional treatments. It is illustrated by Ausburn and Ausburn (1978b) in Figure 4.

In terms of required outlay of time and money, it is certainly preferable to produce one supplantational instructional treatment which is appropriate for both high-need and low-need learners. This suggests that there is real value in seeking out ordinal interactions between cognitive style and instructional designs rather than the disordinal ones which it is fashionable to seek in ATI research. However, very little is known at this

time about the supplantation capabilities of various instructional techniques or about distinguishing between cases in which single or dual treatments are predicted to be appropriate. These things are at present not under the control of well-established predictive theory and must, unfortunately, be left largely to the instructional designer to determine in individual cases. The establishment of generalizable theory in these areas is a significant need for research in instructional design and cognitive style.

IV. INSTRUCTIONAL TREATMENTS

An approach to developing predictive theory for interrelating learning tasks, learners' cognitive styles, and instructional treatments can be made by beginning with the theoretical relationships posited in Table 1 between certain types of tasks and certain cognitive styles. The tasks and cognitive styles in the table are related via the information-processing functions required by the task and those theoretically controlled or influenced by the cognitive styles. Based on these relationships, it is possible to predict some instructional treatments which appear to be capable of providing supplantation of required task functions which learners with certain cognitive styles might have difficulty performing. The following is a discussion of potentially useful supplantational instructional treatments for the classes of tasks listed in Table 1.

Tasks Requiring Discrimination and Analysis of Visual Details. Typical of this classification would be tasks requiring interpreting of visual materials, such as maps, charts, diagrams, and pictures. As long as these types of visuals are kept relatively simple, they are not likely to conflict with cognitive style. However, complex visuals might cause difficulty for learners who have field-dependent, haptic, constricted field control, or impulsive cognitive styles. The requirement of discrimination and analysis of details in complex visuals might be supplanted by using such techniques as graphic emphasis (arrows, heavy lines, circling, etc.), color-coding, progressive disclosure, or overlays. These techniques would focus attention on specific portions of the material and limit the amount of visual information in the stimulus field at a given time. This would serve to help disembed details

from background, point out relationships among elements, and control and guide attention deployment in the stimulus field. The visual supplantation can be reinforced by the addition of verbal cues, such as "Now move from the red portion of the diagram to the green portion," or "Look at the section of the picture enclosed in the circle."

Tasks Requiring Comparison or Matching of Visual Details. When it is necessary to compare details in two or more complex simultaneously-presented maps, charts, diagrams, pictures, etc., difficulties encountered in the visual discrimination tasks are compounded for learners with field-dependent, haptic, constricted field control, or impulsive cognitive styles. Here also, techniques using graphic cueing and controlled presentation rate of details, coupled with reinforcing verbal cues, can provide supplantation by disembedding details and controlling attention deployment.

Tasks Requiring Visualization of Processes or Objects. When a task requires that mental images of processes or objects be formed, the visual/haptic dimension of cognitive style is likely to be significant. If a problem or process can be understood abstractly through verbalization, haptics (who have difficulty forming mental imagery and are disinclined to do so) will probably do so, and will therefore be at no important disadvantage with the learning task. However, if visualization is essential to a task (as, for example, in some types of geometry problems or some spatial orientation tasks), haptics are likely to encounter difficulty if a verbal treatment is used, as verbalization increases the necessity for learner-generated imagery. When imagery is mandatory for task comprehension, extremely haptic learners can have problems with what seems to more visual individuals to be relatively simple imagery formation. This suggests that care needs to be taken by instructors who are themselves visual to avoid the assumption that "anyone can see that."

In some cases involving visualization in a learning task, the need for supplantation may be felt by visuals as well as by haptics. When the object or process to be understood is extremely complex visually (as, for example, rotations of axes in multi-dimensional space),

haptics are likely to attempt to deal with and accept it at an abstract conceptual level. If this is possible, haptics will generally be quite content with a non-visual learning mode. Extreme visuals, however, are highly reliant on the visual modality for learning and are not likely to accept a verbal abstraction. They are likely to reject the abstraction and to continue to struggle with complex imagery formation - i.e., to "see" the concept - in order to accept and comprehend it. Supplantation is then necessary for them.

Supplantation of visualization requires, obviously, the use of visual representations of items or processes to augment verbal abstractions. Items can be made visual by using real objects or models, or by graphic or photographic representation. Observable processes can be shown visually in still form by means of sequential photographs or diagrammatic representation. Motion can be given to observable processes by using video or motion picture film, or with models with moving parts or components. Processes or concepts which are unobservable or theoretical can be represented visually in still form by means of diagrams and in motion form by means of animated film or moveable mock-ups. The choice of a supplantation technique for visualizing an item or process should be guided by the nature of the concept to be represented and the resources available.

Tasks Requiring Mental Manipulation of Images.

Tasks in this class bear much the same relationship to tasks requiring mental imagery formation that tasks requiring comparison of visual details bear to those requiring discrimination and analysis of visual details. That is, tasks requiring mental manipulation of images represent an extension of the processing required in the formation of mental images. Image manipulation might include such things as rotating images to view them from a different perspective, altering a feature or characteristic of an image as some process acts on it, or shifting an item in a group so that its position is changed in relationship to other items. Supplanting the mental manipulation of images clearly necessitates representation in a visual form of sequential changes in image elements. This might be provided by means of a sequence of pictures or drawings, moveable models or mock-ups, or use of live or animated film.

Tasks Requiring Mental Integration of Separate Visual Elements. When bits of visual detail from several different sources must be mentally combined or integrated into a total image or "big picture," the visual/haptic cognitive style dimension is likely to be relevant, as haptics have difficulty performing this function. If the separate pieces of information can be integrated conceptually, without imagery (such as might be done, for example, in taking readings from a group of separate instruments and integrating them to determine the operational conditions within a piece of equipment, or in combining bits of verbal information into a scenario), haptics are not likely to be at any disadvantage. However, if a task requires the integration of separately perceived details into a visual whole (as, for example, might be required in viewing separate components of a piece of equipment and having to visualize what the assembled item would look like), haptics are likely to encounter difficulty. A task requiring assembly of an item consisting of numerous parts might cause problems if instructions rely too heavily on mental integration of components rather than on supplantational techniques.

Several techniques can be predicted to be helpful in supplanting mental integration of separate visual elements. These include making all elements visible simultaneously; displaying the elements in a physical arrangement which suggests how they fit together; and providing real objects, models, or photographic/graphic representations of the complete item. These techniques would show what the component elements are, how they fit together, and what the item looks like when all elements are integrated. In cases where extreme difficulty is encountered with the element-integration process, the use of live or animated film of the assembly process might provide a high degree of supplantation.

Tasks Requiring Use of Kinesthetic or Tactile Stimuli. When a task involves the use of input from non-visual body senses - such as tactile impressions, muscular sensations, or spatial orientation from physiological cues such as gravitational pull - the visual/haptic cognitive style is of potential significance. The early literature on field independence/dependence also suggested that this style dimension might be related to ability to use kinesthetic cues analytically

rather than being dependent on the visual field. However, this aspect of field independence/dependence does not appear to present as clear a conceptualization of non-visual learning as does the visual/haptic construct, thus the present discussion will focus on the latter aspect of cognitive style.

It appears from a consideration of the theoretical framework of the visual/haptic typology that both visuals and haptics are capable of learning through kinesthetic/tactile stimuli. The important difference between the two types lies in the manner in which they process and use these stimuli. According to the theory of the visual/haptic typology (Lowenfeld & Brittain, 1970), visuals process kinesthetic/tactile information by mentally integrating its separate components and transforming it into holistic visual images. Haptics, on the other hand, do not integrate kinesthetic/tactile stimuli or transform them into visual images; they are content with partial impressions and with the kinesthetic/tactile modality itself.

This theory suggests that if a task involving kinesthetic/tactile impressions can be performed by either direct use of the non-visual cues or by transforming them to visual images, then haptics and visuals will adapt the learning stimuli to their own preferred processing mode and will thus be able to perform the task without supplantation. If, however, the task requires transformation of kinesthetic/tactile data into integrated visual images, haptics are likely to encounter difficulty.

Supplanting the kinesthetic/tactile-to-imagery transformation can be accomplished by providing the necessary images or image-fields for the learner simultaneously with the non-visual stimuli. This supplants the imagery-formation processing and alters the task from one requiring stimulus transformation to one requiring paired-associate learning. The learner is now required to remember associations between certain kinesthetic/tactile impressions and certain visual images and holistic impressions. While haptics may have difficulty remembering visually the details of an image even after having seen it, it is likely that they will remember where important elements are located in relationship to self or to each other, even if the memory is verbal or conceptual rather than visual.

Tasks Requiring Short-Term or Long-Term Recall of Details of Images. When a task requires the mental storage and recall of the details of visual stimuli - as, for example, in making visual comparisons between details in pictures, diagrams, etc. - the visual/haptic and leveling/sharpening dimensions are likely to be influential, as both are concerned with ability to form and "hold" image details mentally. If learners with haptic or leveling styles have difficulty in remembering comparative details in a sequence of images, an appropriate supplantational technique is to show the images simultaneously rather than sequentially. This alters the nature of the task, changing its visual memory requirement to one of visual discrimination and analysis.

The use of simultaneous rather than sequential images supplants short-term visual memory. When long-term memory of image details is required, supplantation is more difficult. It is probably not possible to induce actual memory retention of visual details over a period of time in extremely haptic or leveling learners. Probably, it is, only possible to supplant the need for this memory by re-presenting the image to the learners periodically.

Tasks Requiring Selecting a Response from among Multiple Alternatives. When a task requires response selection from among several alternatives, the reflective/impulsive dimension of cognitive style may be significant. When faced with response uncertainty and multiple alternatives, impulsives tend to make rapid and frequently incorrect selections rather than delaying response while making systematic evaluation of all alternatives. Kagan and his associates have tended to attribute impulsivity to the valuing of rapid performance above error-free performance (Kagan, 1966) or to lack of concern for error (Kagan & Kogan, 1970). In contrast, other researchers (Block, Block, & Harrington, 1974) have attributed impulsivity to acute anxiety and consequent need to escape in a situation in which a familiar response is unavailable and the learner lacks the capabilities (such as fine discrimination and systematic scanning) to seek the correct alternative from among those available.

Whatever the cause of impulsive responding, this style seems to manifest itself in learning situations in which there exist response uncertainty and multiple response alternatives available simultaneously. This suggests that the impulsive learner is disturbed by the presence of several possible choices at once and cannot conduct a systematic analysis in the presence of multiple stimuli. If this is the case, an appropriate supplantational technique might be to present response alternatives sequentially rather than simultaneously. By using a progressive disclosure of alternatives, the entire range of choices is built up gradually, focusing attention on each alternative in turn and thus helping the learner conduct a systematic analysis and comparison of available choices.

V. IMPLICATIONS

The schema proposed here for linking learners with learning tasks is based on information processing. It is proposed that tasks be analyzed in terms of what basic processing functions they require and that learners be analyzed in terms of processing functions in which they might be weak due to their cognitive style characteristics. It has been pointed out that not all learning tasks have processing requirements which are relevant to cognitive style; some tasks have requirements which are more closely related to other learner characteristics. However, when a task does require an information-processing modality which is incompatible with the characteristics of a certain cognitive style, then cognitive style is likely to be an important factor in successful performance of the task and should be considered in designing instruction intended to link learner capabilities with task requirements.

Several types of learning tasks which appear to be related theoretically to certain cognitive styles have been discussed here. The method which has been proposed for bridging gaps or discrepancies between task processing requirements and learner processing styles is the use of instructional design based on supplantation of the required processing function. Potential supplantational techniques for various task/cognitive style combinations have been discussed here. The proposed task/cognitive style relationships and the proposed supplantational techniques are based on

theoretical considerations rather than on any body of empirical data, because little data on interaction with instructional designs is currently available in cognitive style research. However, the validity of the proposals offered here is certainly open to scrutiny through programmatic research, and it is highly recommended that such research be undertaken. The development of a body of empirical data on relationships between specific types of learning tasks and cognitive style characteristics and on appropriate supplantational techniques would be a major step in advancing cognitive style research beyond the clinical level of definition, theory, and diagnosis and projecting it onto an operational level in real-life teaching/learning situations.

There are several aspects of learner performance which could be evaluated in research designed to test supplantational techniques in the presence of certain task/cognitive style combinations. Both cognitive/psychomotor task performance and affective response to task could be studied. Cognitive and/or psychomotor performance on a task which a supplantational treatment is applied could be analyzed in terms of both accuracy and response time latency. That is, analysis could be made of the effects of the supplantation on both the quality and the speed of learner performance. Analysis could also be made of the affective impact of the supplantational treatment. For example, it could be determined whether learners report that the task is easier or more pleasant when the supplantation is provided.

In conclusion, a final point concerning the use of supplantation merits mention. The utilization of supplantation in instruction is task-specific. It is intended to provide assistance for learners with a specific cognitive style in the understanding and mastery of a specific style-eliciting or style-dependent task. However, while the use of supplantation is specific instruction may well be extremely valuable and successful for a specific task, it should not be assumed that it alters learners' basic cognitive style characteristics or "teaches" them to process information in a new way. Neither should it be assumed that supplantation results in a transfer effect which enables learners to perform similar tasks without supplantation. In situations in which "on-the-job"

functioning requires regular performance of tasks with certain information-processing requirements, it is probably wise to consider the aptitude of potential employees for the required processing mode. Constant provision of supplantation is not feasible in a working situation. This suggests that for employment purposes - as opposed to the teaching of a specific task - aptitude testing based on cognitive style characteristics might be worthwhile.

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APPENDIX A

AN ANALYSIS OF THE WEAPONS MECHANIC COURSE OBJECTIVES: AN APPLICATION OF THE PROPOSED TASK ANALYSIS SCHEMA

As a trial attempt at applying the task analysis schema proposed in this report to an existing course, the Air Force Weapons Mechanic course was utilized. The tasks analysis was performed using the performance objectives listed in Plan of Instruction 3ABR46230-2, -3, -4, Volume I. The analyzed objectives appear in Appendix B.

In applying the cognitive-style/supplantational task analysis schema to the Weapons Mechanic Course objectives, several significant points were discovered. Although many of the objectives specified tasks unrelated to cognitive style, a large number of them appeared to be cognitive-style-related and to be good candidates for analysis via the schema proposed here. Thus, the use of the task analysis schema based on cognitive style was judged to be a useful approach which led to discussion of numerous course objectives and to recommendations for effective instruction.

In analyzing the course objectives, it was recognized that student performance on all learning tasks - even those which have a cognitive style component - is subject to the influence of a variety of individual differences (i.e., motivation, general ability, specific aptitudes, attitudes and personality, previous training and experience, etc.). It was also recognized that instructional treatments which help to overcome task aspects related to cognitive style may not affect other reasons for student failure on a task. Thus, while cognitive-style-based task analysis and the development of appropriate supplantational instruction may solve learning problems for some students, it cannot be assumed that even a very good supplantational treatment will be a panacea which will assure student success. A student may well fail in a task for some reason other than a cognitive style/learning task mismatch. If a student's failure is not cognitive-style-related, then a treatment aimed at cognitive style will not result in success for that student. This suggests two significant points:

1. Supplantational treatments based on cognitive style address only a single aspect of student performance. They help eliminate one potential source of failure, but they should not be expected to account for all possible sources. In designing instruction, other sources of student failure should also be considered and assistance provided in any way possible. This instructional assistance might include techniques designed to motivate and interest; to overcome personality problems, such as acute anxiety; to provide remediation for missing background training; and to provide non-cognitive-style-related supplantation, such as for verbal memory skills or reading ability.

2. If a student fails with a cognitive-style-related task even when supplantation is provided for cognitive style problems, it may be difficult to determine whether the treatment is faulty or whether some other student characteristic is responsible for the failure. Thus, a treatment should not be rejected without careful study of alternative sources of student failure.

Another point which became clear while analyzing the objectives for the Weapons Mechanic Course is that it is very difficult to determine the extent or degree to which cognitive style is likely to influence ability to perform a task. It was found to be relatively simple to locate tasks which appeared to have a theoretical relationship to cognitive style, but it was not possible to quantify what level of a given cognitive style would be required to cause problems on a given task, or how serious these problems would be. This means it is very difficult to determine how necessary supplantation is (mandatory? highly beneficial? mildly helpful?) and what its level of benefit would be (enable student to perform a task that otherwise could not be accomplished at all, improve student's performance and/or shorten training time, improve student's attitude toward the task). Supplantation related to cognitive style might provide any of the following levels of benefit:

1. Make the task somewhat simpler, improving the student's attitude toward it, and lessening the amount of effort that must be exerted to master it.

2. Prevent the student from taking one look at a task and thinking, "I can't do that!" causing fears and

negative expectations which could be self-fulfilling.

3. Actively improving the student's ability to perform the task in terms of increased quality of performance and/or decreased training or performance time.

4. Making it possible to master a task which the student otherwise could not do at all.

Little is known at this time about how necessary various processing skills and aptitudes are to various tasks or about predicting levels of benefit for supplantational treatments. Experimental research is recommended in order to provide empirical data bearing on these issues, which would aid instructional designers in determining pay-off and cost/effectiveness of supplantational techniques.

A related issue concerns whether or not learners with low need for supplantation in a given task may be slowed down or otherwise hampered by the instruction given to high need learners. Again, more research is necessary in order to establish predictive theory in this area. The most economical solution -- in terms of both time and money -- to instructional problems is to locate a single treatment which is beneficial (or at least not detrimental) to all learners. In many cases, a single supplantational treatment related to cognitive style appears to provide this solution. However, little is known at this time about cases requiring single and dual instructional treatments, and experimental research is recommended in order to establish guidelines for pay-off predictions.

Perhaps the most significant thing that was learned from this application of the cognitive-style/supplantation task analysis schema to the objectives of the Weapons Mechanic Course was that analysis of the characteristics and requirements of tasks is extremely difficult without detailed knowledge of the subject matter involved. Insufficient expertise in the subject field makes it difficult to know exactly what type of processing will be required of learners in order to succeed with a task. A subject-matter specialist might easily see task requirements that a non-specialist would overlook or, conversely, might see that what appeared as a requirement to a non-specialist could actually be processed in some alternative manner if the student so chose. It is a major

recommendation of the developers of the cognitive-style/
supplantation task analysis schema that the analysis be
undertaken not by task analysis specialists alone, but
by either subject specialists in conjunction with trained
task analysts or subject specialists who are also trained
in the use of the analysis schema.

APPENDIX B

ANALYSIS OF SPECIFIED COURSE OBJECTIVES, WEAPONS MECHANICS COURSE

The criterion objectives used in this analysis are those listed in Plan of Instruction 3ABR46230-2, -3, -4 (Weapons Mechanic), Volume I. This Volume contains the first six blocks of instruction for course 3ABR46230-2, -3, -4. Each objective is listed, and then it is discussed and analyzed according to the schema proposed in Part I of this report.

BLOCK I. ORIENTATION AND BASIC ELECTRICITY

1. Orientation: No performance objectives specified
2. Career Field Orientation and Air Craft Familiarization

OBJECTIVE: Given statements, correctly select one which explains what is required to progress from the 3 level to 5 level, 5 level to 7 level, or 7 level to 9 level.

- (1) Progression in 462XO career ladder
- (2) OJT
- (3) CDC

ANALYSIS: This objective requires only the processing and recall of verbal data. It is not related to cognitive style.

OBJECTIVE: Given statements of weapons mechanic duties, correctly identify those statements which describe duties performed by the 46230.

ANALYSIS: This objective requires only the processing and recall of verbal data. It is not related to cognitive style.

OBJECTIVE: Given statements, correctly select one which best describes the purpose of the Human Reliability Program.

ANALYSIS: This objective requires only the processing and recall of verbal data. It is not related to cognitive style.

OBJECTIVE: Given statements of Air Force Command Missions, correctly select the statement which identifies the Weapons Mechanic's role in support of TAC, SAC, and ADC missions.

ANALYSIS: This objective requires only the processing and recall of verbal data. It is not related to cognitive style.

3. Objectives missing for this Section

4. Theory of Electron Flow

OBJECTIVE: Given a list of statements, identify those that define the attraction or repulsion of charged particles.

- (1) Static charges
- (2) Like charges
- (3) Unlike charges

ANALYSIS: This objective requires basically the processing and recall of verbal data, and is thus probably not related to cognitive style. However, it is possible that teaching the concepts of electrical attraction and repulsion may entail the use of diagrammatic material. If so, this material should be kept simple to control the possibility of unfavorable interaction with field dependent, haptic, constricted field control, or impulsive cognitive styles. The use of simple diagrams could be quite helpful in providing supplantation of the visualization of the concept of electrical attraction and repulsion (especially for extremely haptic students), but if the diagrams are too complex, requiring too great an amount of discrimination and analysis of visual details, they may be ignored (in favor of a verbal conceptualization) by students with field dependent, haptic, constricted field control, or impulsive cognitive styles. Thus, the general usefulness of visual representations of electrical charges and the resulting attraction or repulsion in augmenting the understanding of a verbal presentation of the concepts is likely to be far greater if the visuals are kept simple.

OBJECTIVE: Match terms concerning electron flow to a list of definitions.

- (1) Valence electrons
- (2) Free electrons
- (3) Potential difference

ANALYSIS: This objective, like the previous one, can be dealt with as a verbal recall task, and so can be disassociated from cognitive style. Again, if visual material is used to help illustrate the concepts involved, it should be kept simple. Students with field dependent, haptic, constricted field control, or impulsive cognitive

styles may largely ignore complex visuals rather than deal with the confusion they present to them and rely instead on verbal comprehension. Since a verbal comprehension of the concepts involved is probably adequate to meet the performance specified in the objective, cognitive style is not likely to have any important bearing on performance on the objective.

OBJECTIVE: Given the name of an electronic component and four schematic symbols, select the symbol which represents the component.

- (1) Switches
- (2) Battery
- (3) Lamp
- (4) Resistor
- (5) Wire connections
- (6) Fuze
- (7) Circuit breaker
- (8) Ground

ANALYSIS: This objective requires the association of verbal/visual pairs. In order to correctly identify the visual symbol which is associated with a verbal one, it is necessary to recall visual images studied previously. Whether the visual memory task is likely to interact with cognitive style depends on the extent to which visual detail must be discriminated and remembered. If the four schematic symbols presented in the task specified in the objective are to be similar variants, this means that students must note and recall details of the correct schematic. If this is the expectation, then the initial task for students in learning the schematic symbols for electronic components involves discrimination and analysis of visual details and mental storage of these details. Selection, as specified in the performance objective, of the correct schematic symbol from among four similar variants further requires comparison of visual details in the variants, recall of the details of the correct schematic, and analytically selecting a response from a highly similar multiple visual array. Several cognitive styles might be related to performance on both the initial learning task and the performance as specified in the objective. These include field dependent, haptic, leveling, constricted field control, and impulsive cognitive styles. Supplantational instructional techniques which might be helpful would include using graphic and verbal cueing to focus students' attention on relevant details of the schematic symbols when

they are presented for learning, and practice in discriminating incorrect variants from the correct one.

If the task specified in the objective is intended to require only the recognition of the correct schematic symbol from among a group of grossly dissimilar alternatives, the relationship with cognitive style is likely to be minimal. In this case the students are required to perceive and store only the general configuration of the schematic symbol which is associated with each electronic component and to recognize it in a group of dissimilar alternatives. Far less discrimination, storage, and recall of visual detail is required in this case than in the one discussed above, and cognitive style is thus likely to be of far less significance.

5. Powers of Ten and Metric Conversion

OBJECTIVE: Given a decimal number or a number in powers of ten, select its equivalent from a given list.

- (1) Powers of ten
- (2) Metric conversion

ANALYSIS: This objective requires knowledge and application of mathematical skills and conversion factors and is not related to cognitive style.

OBJECTIVE: Given two decimal numbers, multiply or divide them and select the answer, expressed in powers of ten, from a given list.

- (1) Multiplication
- (2) Division

ANALYSIS: This objective requires the knowledge and application of mathematical skills and is not related to cognitive style.

6. Measurement Test and Test Critique

BLOCK II. D.C. CIRCUITS

1. Resistance and the AN/PSM-6 Multimeter

OBJECTIVE: Given a list of statements describing various types of resistors, identify the correct statements.

- (1) Function of resistors
- (2) Carbon composition resistors
- (3) Variable resistors
- (4) Wirewound resistors

ANALYSIS: This objective requires the processing and recall of verbal information, and is not related to cognitive style.

OBJECTIVE: Given the color code for a resistor, compute the minimum and maximum ohmic value.

- (1) Color coded value
- (2) Color coded tolerance

ANALYSIS: This objective requires the processing and recall of verbal information concerning the resistor color code, and the knowledge and application of mathematical laws and skills. It is not related to cognitive style.

OBJECTIVE: Given an AN/PSM-6 multimeter and a resistor, measure the resistance to the nearest graduation.

- (1) AN/PSM-6 ohmmeter function
- (2) Resistance measurements

ANALYSIS: This objective requires knowledge of the correct use of the AN/PSM-6 multimeter. Learning to use this piece of equipment could be related to cognitive style, because the equipment is complex in terms of the visual field of stimuli it presents. Since the multimeter comprises a complex visual array, discrimination and analysis of its components might be made easier for field dependent, haptic, constricted field control, and impulsive students through the use of visual and verbal attention-focusing and cueing techniques as each component is discussed. One alternative might be to begin instruction with a progressive series of illustrations of the multimeter, gradually building up its elements in an increasingly-complex visual field, explaining the function and operation of elements as they are added. Then instruction could proceed with the real item.

2. D.C. Electricity

OBJECTIVE: Select the statement in a given list that correctly describes the basic principles of a battery, generator, or power supply operation.

- (1) Battery
- (2) DC generators
- (3) DC power supply

ANALYSIS: This objective appears to require the processing and recall of verbal data and to be unrelated to cognitive style. However, if it is necessary to visualize the process of operation in order to understand

it (that is, if understanding cannot be gained through verbal comprehension), students with a haptic cognitive style are likely to encounter difficulties. Visualization of the process could be supplanted in the instruction by using diagrams, models, or animated film.

OBJECTIVE: Given a circuit schematic with two known values, calculate the unknown value of E, I, or R using Ohm's law.

- (1) Voltage (E)
- (2) Current (I)
- (3) Resistance (R)

ANALYSIS: A portion of this objective could be related to cognitive style, i.e., learning to read a circuit schematic. If the visual stimulus array produced by the schematic is complex, or impulsive cognitive styles might encounter difficulty with the visual discrimination and analysis required. Supplantation could be provided by providing verbal and graphic cueing in initial presentations of schematics and following a step-by-step analysis of how to read a schematic, perhaps using progressive disclosure of details. This supplantational assistance would be particularly important while the students were attempting to become familiar with the visual conventions of schematic representation. Since the same visual codes are used in all circuit schematics, it seems probable that once students have been trained in a procedure for analyzing and interpreting them, the need for supplantation would be likely to disappear.

The calculation aspect of this objective requires knowledge and application of mathematical laws and skills and is not related to cognitive style.

OBJECTIVE: Given a series circuit schematic with designated known values, use Ohm's and Kirchoff's laws to calculate the unknown voltage, current, or resistance values.

- (1) Series circuits
- (2) Ohm's law
- (3) Kirchoff's law

ANALYSIS: Understanding the operation of a series circuit probably requires visualization of its components, relationships, and processes. This visualization is likely to be difficult for students with a haptic cognitive style, and even for those with a visual style if the visualization required is complex. Supplantation

can be provided through the use of diagrams and/or models of series circuits. The potential cognitive-style-related problems in learning to read circuit schematics has already been discussed.

The calculation aspect of this objective requires knowledge and application of mathematical laws and skills and is not related to cognitive style.

OBJECTIVE: Given a multicomponent series circuit, use an AN/PSM-6 multimeter to correctly measure unknown resistance, voltage, or current values to within the nearest graduation.

- (1) Safety
- (2) AN/PSM-6 multimeter
- (3) Measuring techniques

ANALYSIS: Assuming the previously-discussed potential cognitive-style-related problems in learning to use the multimeter have been overcome, this objective requires the knowledge and application of technical information and manual skills and mathematical skills and is not further related to cognitive style. It should, however, be noted that it appears that this objective and ones following require the acquisition of additional skills in operating the multimeter, i.e., its use to determine voltage, current, and resistance in series, parallel, and series-parallel circuits. If this is the case, it may well be necessary to use focusing and cueing instructional techniques similar to those discussed previously in conjunction with the multimeter.

OBJECTIVE: Given a parallel circuit schematic with designated known values, use Ohm's law and Kirchoff's law to calculate the unknown voltage, current, or resistance values.

- (1) Parallel circuits
- (2) Ohm's law
- (3) Kirchoff's law

ANALYSIS: The same discussion applies to this objective that applies to the similar one above relating to series circuits.

OBJECTIVE: Given a multicomponent parallel circuit, use an AN/PSM-6 multimeter to correctly measure unknown resistance, voltage, or current values to within the nearest graduation.

- (1) Safety
- (2) AN/PSM-6 multimeter
- (3) Measuring techniques

ANALYSIS: The same discussion applies to this objective that applies to the similar one above relating to series circuits.

OBJECTIVE: Given a series-parallel circuit schematic with designated known values, use Ohm's and Kirchoff's laws to calculate the unknown voltage, current, or resistance values.

- (1) Series-parallel circuits
- (2) Ohm's law
- (3) Kirchoff's law

ANALYSIS: The same discussion applies to this objective that applies to the similar one above relating to series circuits.

OBJECTIVE: Given a multicomponent series-parallel circuit, use an AN/PSM-6 multimeter to correctly measure unknown resistance, voltage, or current values to within the nearest graduation.

- (1) Safety
- (2) AN/PSM-6 multimeter
- (3) Measuring techniques

ANALYSIS: The same discussion applies to this objective that applies to the similar one above relating to series circuits.

3. Objectives Missing for This Section

4. Troubleshooting Fundamentals

OBJECTIVE: Identify the malfunction when given a schematic, the malfunction symptom, and circuit conditions.

- (1) Opens
- (2) Shorts
- (3) Component failure

ANALYSIS: Assuming the potential cognitive-style-related problems in learning to read circuit schematics have been overcome, this objective requires the knowledge and application of verbal data, and is not further related to cognitive style. If diagrammatic material is used to teach the concepts of opens and shorts, it should be kept simple or employ graphic and verbal cueing.

OBJECTIVE: Using the AN/PSM-6 multimeter, locate the malfunctioning component in the resistive circuits trainer.

- (1) Troubleshooting with a voltmeter
- (2) Troubleshooting with an ammeter
- (3) Troubleshooting techniques

ANALYSIS: Assuming the potential cognitive-style-related problems in learning to use the multimeter have been overcome, this objective requires the knowledge and application of technical information and manual skills and is not further related to cognitive style.

5. Measurement Test and Test Critique

BLOCK III. A.C. CIRCUITS

1. Principles of Generation, Alternating Current, and Relays

OBJECTIVE: Match the various parts of an AC waveform with the appropriate terms, given a list of terms and an illustration.

- (1) Reference
- (2) Cycle
- (3) Period
- (4) Alternation
- (5) Amplitude

ANALYSIS: It appears from the Support Material and Guidance accompanying this objective that it will be preceded by learning of concepts concerning principles and generation of AC, electromagnetism, and relays, and that this learning will be necessary in order to meet this or subsequent objectives. The concepts involved require the comprehension of abstract processes. Further, it seems likely that some visualization of these processes may be necessary to their comprehension. Supplantation of the visualization of the processes may be necessary for students with a haptic cognitive style (and even for those with a visual style if the visualization required is complex), and could be provided through the use of simple diagrams, models, or animations.

The actual performance called for in this objective requires the knowledge of parts of a drawing of a waveform. This would seem, on the surface, to require visual memory skills and to be related to cognitive style. However, the visual to be analyzed is simple and the parts of the waveform can be comprehended and remembered as verbal data, i.e. "The amplitude is

the height of the wave." Therefore, this objective is probably not related to cognitive style.

OBJECTIVE: Calculate unknown voltage and current values of AC waveforms, given peak-to-peak or effective values.

- (1) Peak
- (2) Peak-peak
- (3) Effective value

ANALYSIS: It is probable that some visualization of electrical processes may be necessary in order to grasp the peak-to-peak and effective value concepts. If so, supplantation could be provided through the use of diagrams or animation. These visuals should be kept simple in order to avoid producing of complex visual fields. Once these concepts are understood, this objective requires technical and mathematical knowledge and skills and is not further related to cognitive style.

OBJECTIVE: Measure an unknown AC voltage using the AN/PSM-6 multimeter. Reading must be accurate to the nearest graduation.

- (1) Safety precautions
- (2) Meter set-up

ANALYSIS: Assuming the potential cognitive-style-related problems in learning to use the multimeter have been overcome, this objective requires the knowledge and application of technical knowledge and manual skills and mathematical scaling skills and is not further related to cognitive style.

OBJECTIVE: Given an illustration of a relay, label its parts.

- (1) Armature
- (2) Restoring force
- (3) Switching contacts
- (4) Actuating coil
- (5) Terminals

ANALYSIS: If the illustration used to teach the component parts of a relay is visually complex, students with field dependent, haptic, constricted field control, or impulsive cognitive styles could be assisted with the visual discrimination and analysis task through the use of graphic and verbal cueing techniques.

Once the component parts have been discriminated, their descriptions and locations can probably be

remembered as either pictures or as verbal data, so the objective is probably not further related to cognitive style.

OBJECTIVE: Given a list of characteristic differences of relays, select those of a holding relay.

- (1) Standard relays
 - (a) Normally open/Normally closed
- (2) Holding relay

ANALYSIS: This objective appears to require knowledge and recall of verbal information and to be unrelated to cognitive style.

2. Troubleshooting

OBJECTIVE: Given a troubleshooting trainer, use an AN/PSM-6 multimeter to isolate a malfunction to a single subcircuit.

- (1) Schematic analysis
- (2) Troubleshooting techniques
- (3) Troubleshooting procedures
- (4) Repair and parts replacement
- (5) Power distribution

ANALYSIS: Visuals used to teach the concepts involved in schematic analysis and power distribution could cause visual discrimination and analysis problems for students with field dependent, haptic, constricted field control, or impulsive cognitive styles. The visuals should be kept as simple as possible. Where visual complexity is unavoidable, graphic cueing and progressive disclosure could serve to supplant visual discrimination and aid analysis.

If the troubleshooting trainer is visually complex, it also could pose discrimination problems for students with the cognitive styles listed above. This should be taken into account when teaching them to use it. They should be given careful and systematic instruction if they require it.

3. Oscilloscope

OBJECTIVE: Match oscilloscope controls to their functions, given lists of controls and functions.

- (1) Presentation controls
- (2) Vertical controls
- (3) Horizontal controls

ANALYSIS: This objective appears to require knowledge

and recall of verbal information and to be unrelated to cognitive style.

OBJECTIVE: Measure the DC voltage and determine the polarity in a given circuit, using the oscilloscope.

- (1) Safety precautions
- (2) Oscilloscope set-up
- (3) Measurement techniques

ANALYSIS: This objective and the 3 which follow it require operation of the oscilloscope. This piece of equipment and the displays it produces constitute a complex visual field and could produce visual discrimination and analysis problems for students with field dependent, haptic, constricted field control, or impulsive cognitive styles. Supplantation could be provided through the use of cueing techniques, both on the oscilloscope itself and on related instructional graphics. In teaching the various details of the oscilloscope, a series of increasingly-complex diagrams rather than a single complex visual field might be helpful. Assuming the oscilloscope is mastered, the performance required in this objective calls for knowledge and application of technical information and skills and is not further related to cognitive style.

OBJECTIVE: Calculate the peak-to-peak voltage in a given circuit, using the oscilloscope. Compute the effective value of the measured voltage.

- (1) Safety precautions
- (2) Oscilloscope set-up
- (3) Measurement techniques

ANALYSIS: Assuming the oscilloscope is mastered, the performance required in this objective calls for knowledge and application of technical information and skills and is not further related to cognitive style.

OBJECTIVE: Calculate the period (time) of a given waveform, using the oscilloscope.

- (1) Period (time)
- (2) Safety precautions
- (3) Oscilloscope set-up
- (4) Measurement techniques

ANALYSIS: Assuming the oscilloscope is mastered, the performance required in this objective calls for knowledge and application of technical information and skills and is not further related to cognitive style.

OBJECTIVE: Calculate the frequency of an AC sine-wave, using the oscilloscope. Reading accuracy to within $\pm 10\%$ of oscilloscope indication.

- (1) Frequency
- (2) Safety precautions
- (3) Oscilloscope set-up
- (4) Measurement techniques

ANALYSIS: Assuming the oscilloscope is mastered, the performance required in this objective calls for knowledge and application of technical information and skills and mathematical skills and is not further related to cognitive style.

4. Inductor and Capacitor Fundamentals

OBJECTIVE: Given four schematic symbols, correctly select the symbol of a capacitor.

- (1) Basic capacitors
 - (a) capacitance
 - (b) construction
 - (c) basic symbol
- (2) Units of measurement
 - (a) farad
 - (b) microfarad
 - (c) micromicrofarad
- (3) Types of capacitors
 - (a) variable
 - (b) fixed
 - (c) electrolytic

ANALYSIS: This objective appears to test only item 1(c) listed under it. The relationship to cognitive style has been discussed under a similar objective (see Block I, section 4) concerning matching electronic components and schematic symbols.

OBJECTIVE: Given four statements, correctly select the one which is a characteristic of a capacitor.

- (1) Stores energy
- (2) Puts energy back into circuit
- (3) Relationship of size to ability to store a charge
- (4) Opposes DC, passes AC

ANALYSIS: This objective requires knowledge and recall of verbal information and is not related to cognitive style.

OBJECTIVE: Given four statements, correctly select the one which is an application of a capacitor.

- (1) Blocking DC
- (2) Coupling AC
- (3) Bypassing AC
- (4) Filtering

ANALYSIS: This objective requires knowledge, recall, and application of verbal information and is not related to cognitive style.

OBJECTIVE: Given four schematic symbols, correctly select the symbol for an inductor.

- (1) Basic inductor
 - (a) inductors
 - (b) construction
 - (c) basic symbol
- (2) Units of measurement
 - (a) henry
 - (b) millihenry
 - (c) microhenry

ANALYSIS: This objective appears to test only item 1(c) listed under it. The relationship to cognitive style has been discussed under a similar objective (see Block I, section 4) concerning matching electronic components and schematic symbols.

OBJECTIVE: Given four statements, correctly select the one which is a characteristic of an inductor.

- (1) Stores energy
- (2) Puts energy back into a circuit
- (3) Opposes AC, passes DC

ANALYSIS: This objective required knowledge and recall of verbal information and is not related to cognitive style.

OBJECTIVE: Given four statements, correctly select the one which is an application of an inductor.

- (1) Blocking AC
- (2) Filtering

ANALYSIS: This objective requires knowledge, recall, and application of verbal information and is not related to cognitive style.

5. Solid State Devices

OBJECTIVE: Given a list of statements, select the one that describes solid state diodes and their operating characteristics.

- (1) Basic diode construction
- (2) Majority and minority carriers

- (3) Diode types
- (4) Diode biasing

ANALYSIS: This objective appears to require only knowledge and recall of verbal information and to be unrelated to cognitive style. However, this may not be true of the instruction leading up to the objective. Visualization is likely to be needed in order to grasp some concepts listed under the objective, such as diode construction and biasing. Diagrams, graphs, and actual diodes could be used to provide supplantation to assist with visualization of diode construction and of the concept of biasing. Students with a haptic cognitive style may find this supplantation essential in order to gain anything but the vaguest conceptualization of diode construction and biasing, and those with a visual style are likely to find graphic representation of biasing by far the most efficient way to grasp that concept.

OBJECTIVE: Given an assortment of solid state diodes, use an ohmmeter to determine their condition as being good or bad.

- (1) Ohmmeter checks
- (2) Identify cathode
- (3) Identify anode
- (4) Ratio

ANALYSIS: This objective requires knowledge and application of technical information and skills. It is not related to cognitive style.

6. Power Supplies

OBJECTIVE: Given four statements, correctly select the one which defines mutual inductance.

ANALYSIS: This objective requires knowledge and recall of verbal information and is not related to cognitive style.

OBJECTIVE: Calculate the output of a transformer given the input voltage and current, and number of turns in the primary and secondary windings.

- (1) Identify primary and secondary coils
- (2) Transformer operation

ANALYSIS: Understanding transformer operation requires visualization of components and processes within a transformer. This visualization is probably complex enough that students with a visual cognitive style as well as those with a haptic style

are likely to need the supplantation provided by diagrams and/or models of transformer operation.

The actual calculation required in this objective appears to require knowledge and application of technical information and mathematical skills and to be unrelated to cognitive style.

OBJECTIVE: Identify schematic diagrams of different types of transformers.

- (1) Laminated iron core
- (2) Powered iron core
- (3) Air core
- (4) Tapped

ANALYSIS: This objective requires the discrimination and memory of differences in the schematics of various types of transformers. It is probably in the visual discrimination stage that cognitive style will be most important. During this stage of learning, students with field dependent, haptic, constricted field control, or impulsive cognitive styles should benefit from graphic and verbal cueing to help discriminate relevant differences among the various types of schematics.

Also necessary to meet this objective is storage and recall of the various schematics. While this could be done through visual memory, this is probably not mandatory. Students with a visual or sharpening cognitive style will tend to remember the various visual images of the different schematics. Those with a haptic or leveling style will, on the other hand, probably rely on verbal recall of points of difference. Since either strategy will probably be effective, cognitive style is not likely to affect the recall portion of this objective.

OBJECTIVE: Select the operational characteristics of a half-wave rectifier from a given statement.

- (1) Half-wave characteristics
- (2) Advantages
- (3) Disadvantages

ANALYSIS: Conceptualization of operational characteristics of a half-wave rectifier will probably require fairly complex visualization. Both haptic and visual students will probably benefit from the use of visual representations and models of the operation of the rectifier and its functioning.

The actual performance required by this objective appears to be knowledge and recall of verbal information and not related to cognitive style.

OBJECTIVE: Given a half-wave rectifier circuit, obtain a stable output wave shape display on the oscilloscope.

- (1) Safety precautions
- (2) Oscilloscope set-up procedures
- (3) Measurement techniques

ANALYSIS: Assuming that the oscilloscope and the conceptualization of the half-wave rectifier circuit have been mastered, this objective requires knowledge and application of technical information and skills and is not further related to cognitive style.

OBJECTIVE: Select the operational characteristics of a full-wave/bridge rectifier from a given statement.

- (1) Full-wave characteristics
- (2) Bridge characteristics
- (3) Advantages
- (4) Disadvantages

ANALYSIS: The same discussion applies to this objective as to the similar objective above concerning the half-wave rectifier.

OBJECTIVE: Given a full-wave/bridge rectifier, obtain a stable output wave shape display on an oscilloscope.

- (1) Safety precautions
- (2) Oscilloscope set-up procedures
- (3) Measurement techniques

ANALYSIS: The same discussion applies to this objective as to the similar objective above concerning the half-wave rectifier.

OBJECTIVE: Match basic filter types used in power supplies to given schematics.

- (1) Capacitive input filters
- (2) Choke input filters
- (3) Pi-type LC filters
- (4) T-type filters

ANALYSIS: The same discussion applies to this objective as to the similar objective above concerning identifying schematic diagrams of different types of transformers.

OBJECTIVE: Select statements describing basic filter characteristics from a given list.

- (1) Capacitive input filters
- (2) Choke input filters
- (3) Pi-type filters
- (4) T-type filters

ANALYSIS: This objective appears to require knowledge and recall of verbal information and to be unrelated to cognitive style.

OBJECTIVE: Given a rectifier and filter circuit, obtain a stable output wave shape display on an oscilloscope.

- (1) Safety precautions
- (2) Oscilloscope set-up procedures
- (3) Measurement techniques

ANALYSIS: The same discussion applies to this objective as to the similar objectives above concerning half-wave and full-wave/bridge rectifiers.

7. Measurement Test and Test Critique

BLOCK IV. ELECTRONIC FUNDAMENTALS

1. Transistor Fundamentals and Testing

OBJECTIVE: Given schematics of NPN and PNP transistors biased by voltage divider networks, identify the correctly biased schematics.

- (1) Symbols
- (2) Operation
- (3) Biasing

ANALYSIS: The concepts of types of transistors, circuit operation, and biasing voltages will probably require rather complex visualization for comprehension. Both visual and haptic students will therefore probably require the supplantation provided by diagrams and/or models.

The visual field produced by the diagrams and schematics is likely to be complex and to create a difficult visual discrimination and analysis task for students with field dependent, haptic, constricted field control, or impulsive cognitive styles. Supplantation could be provided by graphic and verbal cueing techniques and by use of progressive disclosure of visual elements.

This objective also calls for storage and recall of the details of correct schematics. As discussed in a previous objective concerning identifying schematics of types of transformers (see Block II, section 6), this can probably be done by visual memory (visual and sharpening styles) or by verbal memory (haptic and leveling styles) with equal effectiveness.

OBJECTIVE: Determine the condition of a transistor as being good or bad by using a set of procedures, an ohmmeter, and a diode-transistor trainer.

- (1) Caution
- (2) AN/PSM-6 polarity
- (3) Ratio
- (4) Measurement techniques

ANALYSIS: This objective requires knowledge and application of technical information and skills and is not related to cognitive style.

2. Binary Numbers

OBJECTIVE: Given a binary number, convert to a decimal number and vice-versa.

- (1) Number system
- (2) Binary to decimal conversion
- (3) Decimal to binary conversion

ANALYSIS: This objective requires knowledge and application of mathematical rules and procedures and is not related to cognitive style.

OBJECTIVE: Add or subtract any combination of two binary numbers.

- (1) Addition
- (2) Subtraction

ANALYSIS: This objective requires knowledge and application of mathematical rules and procedures and is not related to cognitive style.

3. Troubleshooting Analysis

OBJECTIVE: Given block diagrams of the paths of signal/data flow, match given types of signal/data flow to the block diagrams.

- (1) Linear path
- (2) Convergent path
- (3) Divergent path
- (4) Convergent/divergent path
- (5) Feedback path

(6) Switching path

ANALYSIS: Conceptualization of various types of signal/data flow will require rather complex visualization for comprehension. Both visual and haptic students will probably require the supplantation provided by diagrams, animations, and/or models.

The relationship of cognitive style to the visual discrimination/analysis aspect of block diagrams and to the storage/recall aspect are discussed under a previous objective concerning NPA and PNP transistor biased schematics (see Block IV, section 1).

4. Logic Circuits, Truth Tables, and Boolean Algebra
(All objectives discussed together in one analysis section)

OBJECTIVE: Identify the input conditions necessary to obtain either a high or low output from an AND, NAND, INHIBITED-AND, OR, NOR or an EXCLUSIVE-OR logic gate.

- (1) AND gates
- (2) NAND gates
- (3) INHIBITED-AND gates
- (4) OR gates
- (5) NOR gates
- (6) EXCLUSIVE-OR gates

OBJECTIVE: Construct a truth table from a given AND, NAND, INHIBITED-AND, OR, NOR, or EXCLUSIVE-OR gate.

- (1) AND gate
- (2) NAND gate
- (3) INHIBITED-AND gate
- (4) OR gate
- (5) NOR gate
- (6) EXCLUSIVE-OR gate

OBJECTIVE: Determine the output logic state from a given diagram containing logic circuit symbols and the inputs.

- (1) Truth tables
- (2) Circuit analysis

OBJECTIVE: Match a Boolean expression to given diagrams.

- (1) Connecting words and symbols
- (2) AND operations
- (3) OR operations

(4) NOT operations

OBJECTIVE: Match a logic diagram to given Boolean expressions.

- (1) Inhibited function
- (2) OR gate
- (3) AND gate
- (4) Logic diagrams

ANALYSIS: These objectives contain several aspects which are related to cognitive style. They require conceptualization of Boolean logic, which generally is visualized in the form of Venn diagrams. Without this visualization, Boolean conceptualization is likely to be difficult for both visuals and haptics. It is usual to use some form of color coding and/or shading techniques to assist learners in the discrimination and comprehension of Venn logic diagrams.

The objectives further require mastery and differentiation of several types of complex logic circuits. The students must conceptualize how the various logical circuits operate, what their input conditions are, how to construct truth tables for them, and what their output logic state will be. Considerable visualization of complex operating procedures and concepts is necessary for both visuals and haptics. Moveable models, use of color-coded diagrams, and animation could be particularly helpful in providing supplantation of the visualization of complex processes in logic circuits. The visual fields produced by the visuals used to provide the needed supplantation will probably be complex, thus producing difficult visual discrimination and analysis tasks for students with field dependent, haptic, constricted field control, and impulsive cognitive styles. Use of color codes and/or progressive disclosure and gradual build-up of components in models, diagrams, animations, etc. could provide needed supplantation.

5. Flip-Flops and Application

OBJECTIVE: Determine the output states (logic states) of RS, T, RST, JK flip-flops when given input conditions.

- (1) Flip-flop familiarization
- (2) Terminology
- (3) RS flip-flops
- (4) T-type flip-flops

- (5) RST flip-flops
- (6) JK flip-flops
- (7) Uses

ANALYSIS: As flip-flops are an extension of logic circuits, the same discussion applies to this objective concerning flip-flop circuits as to the ones in section 4 concerning logic circuits.

6. Measurement Test and Test Critique

7. Soldering Techniques (All objectives discussed together in one analysis section)

OBJECTIVE: Given an electrical soldering iron and assorted materials, meet the specifications of T.O. 00-25-234 for the preparation of soldering tips.

- (1) Tip dressing
- (2) Tip tinning
- (3) Tip maintenance

OBJECTIVE: Given assorted handtools and materials, and meeting the specifications in T.O. 00-25-234, tin six leads.

- (1) Wire stripping
- (2) Wire twist
- (3) Wicking tweezers
- (4) Application of solder
- (5) Cleaning

OBJECTIVE: Given an electrical soldering iron and a soldering kit, solder a Single Side Entry Hook IAW specifications and tolerances in T.O. 00-25-234.

- (1) Hook bending
- (2) Inspection and cleaning
- (3) Wire attachment
- (4) Solder application
- (5) Cleaning

OBJECTIVE: Given assorted tools and materials and meeting specifications and tolerances in T.O. 00-25-234, solder a cup terminal and/or terminal pins.

- (1) Inspection and cleaning of terminals
- (2) Wire connection
- (3) Solder application
- (4) Cleaning

OBJECTIVE: Given assorted tools and materials and meeting specifications and tolerances in T.O. 00-25-

234, solder a Single Side Entry and/or a Double Side Entry Turret Terminal.

- (1) Turret inspection and cleaning
- (2) Wire connection
- (3) Solder application
- (4) Cleaning

OBJECTIVE: Given assorted tools and materials and meeting specifications and tolerances of T.O. 00-25-234, solder two resistors to a printed circuit board.

- (1) Inspection and cleaning of circuit board
- (2) Resistor preparation
- (3) Resistor mounting and attachment to circuit board
- (4) Solder application
- (5) Cleaning

OBJECTIVE: Given assorted tools and materials and meeting specifications and tolerances of T.O. 00-25-234, solder a transistor and/or diode to a printed circuit board.

- (1) Inspection and cleaning of circuit board
- (2) Diode preparation
- (3) Diode mounting and attachment to circuit board
- (4) Solder application
- (5) Cleaning

OBJECTIVE: Given necessary tools and materials, de-solder selected components from a printed circuit card, meeting the specifications of T.O. 00-25-234.

- (1) Desoldering
- (2) Wicking
- (3) Inspection and cleaning of circuit board

ANALYSIS: These objectives appear to be unrelated to cognitive style. They require knowledge of acceptable standards of technical performance (specifications and tolerances), knowledge of purposes and functioning of various tools and equipment, and ability to use the tools to carry out various technical operations. Thus the primary requirements of the objectives appear to be information recall and manual skills and dexterity. While learners with differing cognitive styles may choose to use various combinations of visual/verbal storage and retrieval of information, there is no reason to believe that either mode would be ineffective. Nor is there reason to believe that manual skills are influenced by cognitive style.

BLOCK V. SECURITY, TECHNICAL PUBLICATIONS,
AND INTRODUCTION TO AIRMUNITIONS

1. Security Classification System and Communication Security (All objectives discussed together in one analysis section)

OBJECTIVE: Given a list of simulated situations, DOD ISPR 5200.0, AFR 205-1 and AFP 50-47 Vol. II, identify the information as classified, unclassified, or unclassified but of possible intelligence value.

- (1) Classified information
- (2) Unclassified information
- (3) Unclassified information but of possible intelligence value

OBJECTIVE: Given a list of communication modes, simulated situations, indicate the proper security classification of each situation.

- (1) Top secret
- (2) Secret
- (3) Confidential

OBJECTIVE: Given a list of communication modes, simulated situations, DOD ISPR 5200.1, AFR 205-1, and AFP 50-47 Vol. II, indicate the proper mode required for reliability, security and speed.

- (1) Autovon
- (2) U.S. mail
- (3) ARFCOS
- (4) Autosevocom
- (5) Autodin

OBJECTIVE: Given a list of simulated situations, DOD ISPR 5200.0, AFR 205-1, and AFP 50-47 Vol. II, identify those that could be a security risk in the improper use of any unsecured tele-communications system.

- (1) Telephone
- (2) Teletype
- (3) Radio
- (4) Intercom

OBJECTIVE: Given DOD ISPR 5200.1, AFR 205-1, AFP 50-47 Vol. II, list the security risk involved in an attempt to "talk around" or disguise classified information of possible intelligence value.

- (1) Paraphrasing
- (2) Homemade codes

(3) Comparing with similar subjects

OBJECTIVE: Given a list of simulated situations, DOD ISPR 5200.1, AFR 205-1, and AFP 50-47 Vol. II, outline actions that would prevent a security violation.

- (1) Discuss methods of preventing a security violation
- (2) Plan telephone conversations
- (3) Selection of communication
- (4) Know subject classification

ANALYSIS: These objectives require processing of verbal information. While visuals might be used in instruction for the sake of interest, there is nothing in the tasks that requires visualization or the use of complex visual fields for comprehension. To meet these objectives, students will be required to process a great deal of verbal information. They may or may not choose to remember some of it in visual form according to their cognitive style preferences, but no particular style of processing is mandatory and cognitive style is thus irrelevant to the likelihood of success with the objectives.

2. Resource Security

OBJECTIVE: Describe four actions that can be taken to prevent a resources security violation.

- (1) Establish protection priorities
- (2) Central security control and security alert team
- (3) Establish controlled access areas
- (4) Intrusion detection alarm system

ANALYSIS: This objective requires the processing and recall of verbal information and is not related to cognitive style.

3. Technical Order System

OBJECTIVE: State the types of technical orders and describe their differences.

- (1) Technical manuals
- (2) Index type technical orders
- (3) Abbreviated technical orders
- (4) Time compliance technical orders
- (5) Methods and procedures technical orders

ANALYSIS: This objective requires comprehension and recall of verbal information and is not related to cognitive style.

OBJECTIVE: Given specific aircraft maintenance and inspection problems and a selection of aircraft and munitions systems TOs, select the appropriate TO and locate the requested aircraft technical data.

- (1) TO IF-4C-01
- (2) TO IF-4C-06
- (3) TO IF-4C-2-18
- (4) TO IF-4C-4-6
- (5) TO IF-4C-6

ANALYSIS: This objective requires verbal knowledge of various TOs and application of the knowledge to solve a specific task. It is not related to cognitive style.

OBJECTIVE: Given specific munition problems and a selection of aircraft and munition systems TOs, select the appropriate TO and locate the requested munitions technical data.

- (1) 11A11 -2-7
- (2) 11B29-3-25-2
- (3) 11L1-12-4-32
- (4) 11W1-12-14-32

ANALYSIS: This objective requires verbal knowledge of various TOs and application of the knowledge to solve a specific task. It is not related to cognitive style.

4. Nonnuclear Munitions

OBJECTIVE: Given an aircraft rocket, identify the component parts and describe their function.

- (1) 2.75 FFAR
 - (a) Rocket motor
 - (b) Warheads
 - (c) Fuzes
 - (d) Functional descriptions
- (2) TDU-11/B target rockets
 - (a) Rocket motors
 - (b) Functional description

ANALYSIS: This objective requires the visual discrimination of various types of aircraft rockets and of the component parts of each type. Diagrams, models, and/or realia might be used in instruction. Whichever form(s) of presentation is/are employed, the relationship of the discrimination task to cognitive style will be directly related to the complexity of the visual field entailed. If the visual field is complex, consisting of many components and details, students with field dependent, haptic, constricted field control, and impulsive cognitive styles could encounter difficulty;

if it is fairly simple, consisting of relatively few components and details, cognitive style is not likely to be of importance. If a complex field is present, supplantational focusing and cueing should be provided.

Once visual discrimination is accomplished, storage and recall of the types and components of rockets can probably be accomplished by either visual imagery (for visual and sharpening cognitive styles) or by verbal versions of information (for haptic and leveling styles). Thus, cognitive style is probably not related to the recall portion of the performance required by the objective.

The comprehension and recall of the functional descriptions required by the objective is basically a verbal task and is not related to cognitive style.

OBJECTIVE: Given an aircraft missile, identify the component parts and describe their function.

- (1) AIM-9
 - (a) Guidance and control section
 - (b) Warhead
 - (c) Influence fuze
 - (d) Rocket motor
 - (e) Safety and protective devices
- (2) AIM-4
 - (a) Guidance and control section
 - (b) Warhead
 - (c) Rocket motor
- (3) AIM-7
 - (a) Guidance and control section
 - (b) Warhead
 - (c) Rocket motor
 - (d) Functional description
- (4) AGM-65
 - (a) Forward section
 - (b) Main section
 - (c) Aft section
 - (d) Theory of operation

ANALYSIS: The same discussion applies to this objective as to the one above concerning aircraft rockets. In addition, the theory of operation indicated in item 4(d) may require some supplantation of visualization of the processes involved in missile operation, especially for haptic students. This could be provided through the use of diagrams and animation.

OBJECTIVE: Given an assembled general purpose bomb, identify the component parts and describe their functions.

- (1) MK-82
- (2) M-117
- (3) GBU-10/B
- (4) BLU-27
- (5) SUU-30
- (6) BDU-33B/B
- (7) MK-106

ANALYSIS: The same discussion applies to this objective as to the one above concerning aircraft rockets.

OBJECTIVE: Given a 20mm ammunition display board containing color coded ammunition, identify each round as to type.

- (1) Armor-piercing (AP & AP-T)
- (2) Armor-piercing incendiary (API)
- (3) High-explosive incendiary (HEI & HEI-T)
- (4) Incendiary
- (5) Target practice (TP-T)
- (6) Dummy
- (7) Show film TVL 46-22 (Ammunition Identification and Inspection)

ANALYSIS: Visual discrimination and analysis of the details of the various types of ammunition could be difficult for students with field dependent, haptic, constricted field control, and impulsive cognitive styles. However, the color-coding mentioned in the objective is presumably intended to minimize the need for discrimination and analysis of fine visual details. If this is not the case, care should be taken to focus and cue students' attention to relevant identifying details of the various types of ammunition.

Recall of identifying details is discussed under the objective above concerning aircraft rockets.

OBJECTIVE: Given a list of ammunition conditions, identify each condition as serviceable or unserviceable.

- (1) Minor defects
- (2) Major defects
- (3) Critical defects

ANALYSIS: Assuming potential problems in discriminating components and types of ammunition are overcome, this objective requires knowledge and application of verbal information and is not related to cognitive style.

OBJECTIVE: Given a nose or tail fuze, identify the component parts and describe their function.

- (1) M-904
- (2) M-905
- (3) FMU-7
- (4) FMU-26
- (5) FMU-56

ANALYSIS: The same discussion applies to this objective as to the one above concerning aircraft rockets.

OBJECTIVE: Given a list of impulse cartridges, identify the types and describe their uses.

- (1) MK-2 MOD-1
- (2) MK-1 MOD-3
- (3) MK-9 MOD-0
- (4) ARD 446-1
- (5) ARD 863-1

ANALYSIS: This objective appears to deal with verbal information and to be unrelated to cognitive style. If it is also necessary for students to be able to visually identify the various types of impulse cartridges and their component parts (as suggested by the Instructional Guidance for this section), the same discussion applies to this objective as for the above objective concerning aircraft rockets.

5. Nuclear Munitions

OBJECTIVE: Given a nuclear shape, identify the component parts and describe their function.

- (1) BDU-32
- (2) BDU-35
- (3) B61-0

ANALYSIS: The same discussion applies to this objective as to the objective in section 4 concerning aircraft rockets.

OBJECTIVE: Given a nuclear shape, identify the safety devices and describe their function.

- (1) BDU-32
- (2) BDU-35
- (3) B61-0

ANALYSIS: The same discussion applies to this objective as to the objective in section 4 concerning aircraft rockets.

6. EOD Range Demonstration

7. Measurement Test and Test Critique

BLOCK VI. AUTOMATIC GUNS

1. AFTO Forms 349 and 350

OBJECTIVE: Given problems describing flightline maintenance situations and using TO IF-4C-06, complete an AFTO Form 349.

- (1) Discuss the purpose of the AFTO Form 349
- (2) Discuss the use of the AFTO Form 349
- (3) Discuss the AFTO Form 349 entries

ANALYSIS: This objective appears to require the processing of verbal information and to be unrelated to cognitive style.

OBJECTIVE: Given an AFTO Form 350, and using information extracted from an AFTO Form 349, fill in the appropriate data required for processing action.

- (1) Discuss the purpose of the AFTO Form 350
- (2) Discuss the relationship between the AFTO Form 350 and the AFTO Form 349
- (3) Discuss the AFTO Form 350 entries

ANALYSIS: This objective appears to require the processing of verbal information and to be unrelated to cognitive style.

2. M61A1 20mm Automatic Gun

OBJECTIVE: Given an M61A1 automatic gun, applicable tools, and using TO 11W1-12-3-32, disassemble and assemble the gun.

- (1) Discuss component parts, descriptions and location of each
- (2) Discuss and demonstrate the procedures used in disassembling the M61A1 automatic gun
- (3) Discuss and demonstrate the procedures used in assembling the M61A1 automatic gun

ANALYSIS: To perform this objective, students must first visually discriminate the component parts of the gun. The visual discrimination and analysis task could produce problems for students with field dependent, haptic, constricted field control, and impulsive cognitive styles. Supplantation could be provided by verbal and/or graphic cues (if visuals are used in instruction) to point out both (1) important identifying characteristics of various components, and (2) the location of the parts in relationship to each other.

The disassembly-assembly tasks may cause further difficulties for haptic students. It is likely that students with a visual cognitive style will be able to form and "hold" a mental image of the assembled gun, to look at the disassembled components and mentally reassemble the parts and visualize them in the assembled whole again. This ability to form and manipulate images eliminates much of the need for rote memorization - especially in verbal form - of information concerning how components fit together. Students with a haptic cognitive style, whose mental imagery capacity is quite limited, are more likely to use verbal memory in learning how to disassemble and assemble the components (i.e., "Part C is slipped off over Parts A and B; Part B is then detached from behind Part A."). Since haptics are likely to be more dependent on verbal analysis in learning and remembering the location of and relationships among the components, it is recommended that this sort of analysis be stressed, along with demonstration, in instructing them, thus supplanting the visualization process. Also, since haptic students will probably be unable to form and retain detailed imagery of how the assembled gun looks, they may have difficulty with the re-assembly task after the gun is disassembled. Assistance can be provided by supplanting the use of imagery by giving a careful verbal description while demonstrating assembly (i.e., "Begin with Part A; attach Part B behind it, then slip Part C over A and B.").

It should be noted that verbal analysis of disassembly/assembly procedures is recommended in addition to and not instead of demonstration with a model or a real gun. The use of verbal instructions only would increase rather than decrease the visualization required by the task, thus increasing its difficulty for haptic students. On the other hand, the use of verbal analysis combined with the demonstration ties the visual components to verbal instructions, eliminates the need for mental visualization in learning the disassembly/assembly processes, and provides a non-visual way of remembering them.

OBJECTIVE: Given an M61A1 automatic gun and dummy ammunition, cycle the ammunition through the gun and describe the operational sequence.

- (1) Discuss safety precautions to be observed
- (2) Discuss the function of individual component parts
- (3) Discuss the firing cycle
- (4) Discuss the clearing cycle

ANALYSIS: Visualization of the firing and clearing cycles in the gun is probably necessary for comprehension. If this cannot be illustrated with a model or a real gun, diagrams and/or animated film could be used to provide supplantation, which may be needed by visual as well as haptic students due to the complexity of the concept.

As discussed in the preceeding objective, haptics are likely to be more dependent than visuals on verbal memory for the storage of this information, and a step-by-step verbal analysis to accompany the visual demonstration is recommended to help establish verbal/visual linking.

OBJECTIVE: Given an M61A1 automatic gun, AN/PSM-6 multimeter, and using TO 11W1-12-4-32, perform an inspection and a performance check on the gun.

- (1) Discuss the different types of maintenance
- (2) Discuss the inspection requirements
- (3) Discuss performance checkout procedures

ANALYSIS: Much of the information required by this objective can probably be processed verbally and is not related to cognitive style. However, care should be taken that all technical procedures are demonstrated carefully, avoiding (especially for haptic students) excessive reliance on internal visualization of these procedures.

3. Linkless Feed System

OBJECTIVE: Given the linkless feed system trainer, identify component parts and describe their operational function.

- (1) Discuss the component parts and their location
- (2) Discuss the operating function of component parts

ANALYSIS: The visual array produced by the models, diagrams, etc. of the linkless feed system used for instruction will probably be fairly complex. Verbal and graphic cueing should be used to assist visual discrimination and analysis for students with field dependent, haptic, constricted field control, and impulsive cognitive styles.

If the comprehension of the function of any component parts requires visualization of processes, haptic students (and visual students, if the visualization required is complex) should receive supplantational assistance through use of moveable models, diagrammatic representation, and/or animated film.

Recall of descriptions of operational functions is a verbal task and is not related to cognitive style.

OBJECTIVE: Given a list of statements concerning the linkless feed system, select those that correctly describe inspection criteria and safety precautions to be observed.

(1) Discuss inspection criteria of components

(2) Discuss safety precautions

ANALYSIS: This appears to be primarily a verbal-recall task and not related to cognitive style. However, actual performance of safe inspection - as opposed to verbal description of it - would require visual discrimination and analysis of various components. In teaching students to recognize sound and faulty components, care should be taken to avoid potential problems with cognitive style by illustrating (i.e., visualizing) sound and faulty parts and carefully pointing out (i.e., discriminating) the features which identify them as being sound or faulty. Storage and recall of this information can then be accomplished by either visual or verbal means, depending on the student's cognitive style preferences.

OBJECTIVE: Given the linkless feed system trainer, describe how ammunition is cycled through each component during loading and unloading.

(1) Discuss the procedures for loading ammunition

(2) Discuss the procedures for unloading ammunition

ANALYSIS: As discussed in previous objectives, demonstrations of the loading and unloading procedures should be accompanied by careful verbal instructions. This supplants the need for internal visualization of the procedures and provides a verbal sequence for recall by haptic students who will probably have difficulty recalling the procedures as visual images. Visual students have the option of recall of images rather than rote memory of the verbal sequences if they choose.

Comprehension of the complete cycling of ammunition through each component of the feed system will probably require visualization. This could be supplanted by the use of working models, diagrams, and/or animation. Again, a careful verbal commentary should accompany the visualization.

4. Measurement Test and Test Critique